

Draft Staff Report

North Haiwee Reservoir, Inyo County

Water Quality Sampling Data Summary

and

Proposed Resolution to Remove North Haiwee Reservoir from the Clean Water Act Section 303(d) List of Impaired Waterbodies

California Regional Water Quality Control Board
Lahontan Region
2501 Lake Tahoe Boulevard
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Attachment 1: Resolution 6T-2003-(Proposed)

Acronyms and Abbreviations

AMSL	Above Mean Sea Level
CaCO ₃	Calcium Carbonate
CAO	Cleanup and Abatement Order
C _d /C _t	Dissolved Copper to Total Copper Ratio
Comp	Composite Sample
CTR	California Toxics Rule
Cu	Copper
CV	Coefficient of Variation, defined as the standard deviation divided by the mean
CWA	Clean Water Act
DO	Dissolved Oxygen
LADWP	Los Angeles Department of Water and Power
LAA	Los Angeles Aqueduct
m	Meter
µg/L	Micrograms per Liter
µs/cm	Microsiemens per Centimeter
mg/L	Milligrams per Liter
MRP	Monitoring and Reporting Program
NPDES	National Pollution Discharge Elimination System
pH	Measure of acidity or basicity of a solution; defined as the negative log ₁₀ of the hydrogen ion activity in solution
RWC	Receiving Water Concentration
RWQCB	Regional Water Quality Control Board
SC	Specific Conductance; measure of ability of solution to conduct a current, indicates amount of dissolved solids present in solution
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TSMP	Toxic Substances Monitoring Program
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

INTRODUCTION

Section 305(b) of the Clean Water Act (CWA) mandates biennial assessment of the nation's water resources, and these water quality assessments are used to identify and list those waters which are not achieving water quality standards. The resulting list is referred to as the 303(d) list. The CWA also requires states to establish a priority ranking for these impaired waters and to develop and implement Total Maximum Daily Loads (TMDLs). A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and it allocates pollutant loadings to point and non-point sources such that those standards will be met. A waterbody may be removed from the 303(d) list if it can be demonstrated that water quality standards are being met, or controls are in place to ensure attainment of standards by the next listing period.

Haiwee Reservoir first appeared on the 1994 303(d) list as a result of elevated levels of residual copper in fish tissue levels found through the State Water Resources Control Board's Toxic Substances Monitoring Program (TSMP). It has continued to be listed because of two observed fish kills in the North Haiwee Reservoir in 1991 and 1994 that were linked to copper sulfate applications.

The Los Angeles Department of Water and Power (LADWP) owns and operates Haiwee Reservoir as part of the Los Angeles Aqueduct-Owens River system, which supplies drinking water to Los Angeles. LADWP has historically applied copper sulfate to the reservoir to control algae blooms that impart undesirable taste and odors to the water. LADWP was issued a Cleanup and Abatement Order in 1995 (CAO) by the Regional Board as a result of the fish kills. In response to the CAO, toxicity studies were conducted in North Haiwee and the copper sulfate application practices have been changed. No fish kills have been observed in the reservoir since 1994.

In 2000, Regional Board staff initiated TMDL development for the reservoir complex. In June 2001, a technical TMDL Progress Report was submitted to the USEPA (Lahontan RWQCB, 2001). During TMDL analysis, several key data gaps were identified. The most significant was a lack of information on dissolved copper concentrations. Previous sampling at the reservoirs measured only total copper concentrations and there was no information regarding quality control procedures. This is problematic since the most relevant water quality objectives for copper, California Toxics Rule (CTR) aquatic life criteria, are expressed in the dissolved fraction of copper, which are typically found at lower levels than total copper concentrations. Also, low-level metals sampling should follow stringent quality control procedures during sampling and analysis to avoid sample contamination that may affect the reliability of data. Other data gaps included a lack of concurrent hardness data (needed to interpret hardness-based CTR criteria) and information on vertical water chemistry profiles and reservoir mixing characteristics.

To fill these gaps, Regional Board staff, together with staff from the United States Geological Survey-Carnelian Bay Field Office, conducted water sampling at North Haiwee Reservoir in July and October 2002. The sampling program was designed to gather data to: 1) compare dissolved

copper concentrations in North Haiwee Reservoir with CTR aquatic life criteria; 2) determine the site-specific relationship between dissolved and total copper in the reservoir to aid in interpreting previously collected data and to develop future NDPES permit limits; and, 3) develop an understanding of the seasonal changes in limnological characteristics of the reservoir to refine copper loading capacity estimates.

This report summarizes the information gained from this sampling effort, concludes that North Haiwee Reservoir is meeting water quality standards for dissolved copper, and proposes a resolution to remove North Haiwee Reservoir from the 303(d) list of impaired waters. South Haiwee Reservoir was not included in this sampling program due to logistical issues; therefore, it will remain on the 303(d) list until data is submitted that indicates it is attaining water quality standards for copper.

All figures referred to are contained in Appendix A.

PROJECT AREA DESCRIPTION

The Haiwee Reservoir complex is located in Inyo County, California, near the southern terminus of the Owens Valley. The area is bounded by the Sierra Nevada mountains to the west and the Coso Range to the east. The reservoir is just east of Highway 395, about 23 miles south of Lone Pine at an elevation of approximately 3,760 feet above mean sea level (amsl). The inset map in Figure 1 shows the reservoir location.

The Haiwee Reservoir complex consists of North and South Haiwee Reservoirs, which are separated by an earthen berm known as the Merrit Cut. The reservoir complex was constructed in 1913 as part of the Los Angeles Aqueduct (LAA) system. The reservoir complex is long and narrow and characterized by meandering shorelines. Each reservoir is approximately 3.5 miles long and a quarter mile wide. The North Haiwee Reservoir has a maximum storage of 11,533 acre-feet and a water surface area of approximately 600 acres. Water from the North Reservoir flows southward and can exit the reservoir through Merrit Cut to the South Reservoir or through the Haiwee bypass channel to the second Los Angeles Aqueduct.

SAMPLING PROGRAM OVERVIEW

Ten locations were sampled in the North Reservoir (sites A-J). One sampling location (A) was located near the inlet of the LAA to the North Reservoir. The remaining nine locations were positioned across three roughly equally-spaced transects, placed across the width of the reservoir. Each transect had three sampling sites, two in shallow cove-type environments, and one in deeper water along the centerline of the reservoir (See Figure 1, Sample Location map).

Water samples were analyzed for total and dissolved copper, total organic carbon, total suspended solids and hardness. Field measurements of temperature, pH, dissolved oxygen and specific conductance were taken at one meter vertical intervals at each location. In locations where reservoir depth was greater than 12 feet (sites D, G, and I), depth-discrete samples were

collected from three depths and composited into a single sample for analysis. In shallow locations (less than 12 feet deep), a grab sample was taken from approximately mid-depth.

Sampling events took place on July 23 and October 22, 2002.

DATA DISCUSSION

Copper Concentrations and CTR criteria

All dissolved and total copper concentrations were below acute and chronic CTR criteria, which are established as dissolved concentrations. Average hardness values in July were 71 milligrams per liter (mg/L), with little variation in the dataset (minimum and maximum values were 70 and 73 mg/L, respectively). In October, hardness values increased to an average of 83 mg/L, with a minimum of 81 and a maximum of 85 mg/L. Within the observed range of hardness values, corresponding hardness-based CTR criteria vary from 6.6 micrograms per liter ($\mu\text{g/L}$) for chronic criteria, to 12 $\mu\text{g/L}$ for acute criteria. See Table 1 for total and dissolved copper concentrations and corresponding CTR criteria. Figures 2 and 4 show a graphical representation of CTR criteria and copper concentrations at each sampling location.

Table 1: Reservoir depth at sampling locations, dissolved and total copper concentrations, hardness, and CTR criteria for North Haiwee Reservoir.

Site	Date	Depth to Bottom (ft)	Diss. Cu ($\mu\text{g/L}$)	Total Cu ($\mu\text{g/L}$)	Hardness (mg/L CaCO_3)	CTR Acute (Diss. Cu, $\mu\text{g/L}$)	CTR Chronic (Diss. Cu, $\mu\text{g/L}$)
A	Jul 23 2002	2.5	1.2	5.6	73	10	7
	Oct 22 2002	8.2	1.2	2.7	82	11	7.4
B	Jul 23 2002	11.5	1.7	2.6	71	9.6	6.6
	Oct 22 2002	9.8	1.4	2.5	82	11	7.4
C	Jul 23 2002	8.5	1.3	2.5	71	9.6	6.6
	Oct 22 2002	5.7	1.2	2.4	82	11	7.4
D	Jul 23 2002	30.8	1.6	2.4	71	9.6	6.6
	Oct 22 2002	32.0	1.1	2.2	81	11	7.4
E	Jul 23 2002	11.2	2.2	3.1	71	9.6	6.6
	Oct 22 2002	10.2	1.4	2.4	82	11	7.4
F	Jul 23 2002	7.9	1.6	3.8	71	9.6	6.6
	Oct 22 2002	7.9	1.5	2.3	82	11	7.4
G	Jul 23 2002	27.9	1.3	2.7	71	9.6	6.6
	Oct 22 2002	28.9	1.7	1.9	82	11	7.4
H	Jul 23 2002	5.9	2.4	5.3	70	9.6	6.6
	Oct 22 2002	6.9	2.5	6.4	84	12	7.8
I	Jul 23 2002	28.9	1.9	6.5	70	9.6	6.6
	Oct 22 2002	26.9	2.3	5.8	85	12	7.8
J	Jul 23 2002	8.9	2.0	6.2	70	9.6	6.6
	Oct 22 2002	8.9	2.6	5.7	85	12	7.8

Shaded entries are composite samples in deep water locations, all others are grab samples in shallow cove-type locations.

Dissolved to Total Copper Relationship: Developing a metals "translator" for permit limits and data interpretation

Figures 2 and 4 show the relationship between total and dissolved copper measured at each sampling location. Tables 2 and 3 show measurements of dissolved and total copper, the ratio of dissolved to total copper (C_d/C_t) and the percentage of the total copper that is measured as dissolved, along with summary statistics for each column. Of particular importance is the geometric mean of the ratio C_d/C_t . According to USEPA guidance for calculating a metals translator (USEPA, 1996), the translator is the fraction of total recoverable metal in the receiving water that is dissolved. It may be determined directly by taking measurements of dissolved and total metals concentrations in receiving water, then calculating the ratio C_d/C_t . The translator is the geometric mean of these ratios. The translator is used to develop total recoverable metals permit limits that implement dissolved metals criteria. The translator will be also be used to estimate the amount of dissolved copper that may be represented by previous data collected at the reservoir, which was reported as total copper only.

Table 2: Dissolved and total copper relationships and summary statistics for the July sampling event

Site	Diss. Cu ($\mu\text{g/L}$)	Total Cu ($\mu\text{g/L}$)	C_d/C_t	% Dissolved Cu
A	1.2	5.6	0.21	21
B	1.7	2.6	0.65	65
C	1.3	2.5	0.52	52
D	1.6	2.4	0.67	67
E	2.2	3.1	0.71	71
F	1.6	3.8	0.42	42
G	1.3	2.7	0.48	48
H	2.4	5.3	0.45	45
I	1.9	6.5	0.29	29
J	2	6.2	0.32	32
Geometric Mean	1.7	3.8	0.44	44%
Arithmetic Mean	1.7	4.1	0.47	47%
Minimum	1.2	2.4	0.21	21%
Maximum	2.4	6.5	0.71	71%
Variance	0.15	2.46	0.03	3%

Table 3: Dissolved and total copper relationships and summary statistics for the October sampling event

Site	Diss. Cu ($\mu\text{g/L}$)	Total Cu ($\mu\text{g/L}$)	C_d/C_t	% Dissolved Cu
A	1.2	2.7	0.44	44%
B	1.4	2.5	0.56	56%
C	1.2	2.4	0.50	50%
D	1.1	2.2	0.50	50%
E	1.4	2.4	0.58	58%
F	1.5	2.3	0.65	65%
G	1.7	1.9	0.89	89%

Site	Diss. Cu (µg/L)	Total Cu (µg/L)	C _d /C _t	% Dissolved Cu
H	2.5	6.4	0.39	39%
I	2.3	5.8	0.40	40%
J	2.6	5.7	0.46	46%
Geometric Mean	1.6	3.1	0.52	52%
Arithmetic Mean	1.7	3.4	0.54	54%
Minimum	1.1	1.9	0.39	39%
Maximum	2.6	6.4	0.89	89%
Variance	0.3	2.8	0.02	2%

Shaded entries are composite samples in deep water locations, all others are grab samples in shallow cove-type locations.

As indicated by the geometric mean of the ratio C_d/C_t, dissolved copper represents 44 percent of the total copper detected for the July sampling event, and 52 percent for the October event.

Limnological Characteristics

Field measurements of temperature, dissolved oxygen (DO), specific conductance (SC) and pH were made at one-meter vertical intervals at each sampling location. These data can be used to determine if the reservoir thermally stratifies, defined by a temperature change of greater than one degree Celsius per meter of depth (Horne, 1994). A strong thermal stratification layer could effect the properties of copper diffusion and dilution, as well as lessen the amount of habitable water available that could provide an "escape route" for fish and other mobile organisms to avoid high copper-concentration waters following a copper sulfate treatment. Examination of field data indicates that temperature, pH and DO did not change significantly with depth, indicating a mixed, non-stratified waterbody at the time of sampling. See Tables 4 and 5 for pH, temperature, SC and DO measurements for each sampling location, recorded at the sampling depth. For composite samples, the data recorded is from the first meter of depth. See Figures 3 and 5 for a graphical representation of water temperature vs. depth for each sampling site.

Table 4: pH, temperature, DO and specific conductance per sample for July sampling event

Site	Sample Depth (ft)	DO (mg/L)	pH	Temp (°C)	SC (µs/cm)
A	1.3	7.5	7.7	20.5	348
B	4.9	7.5	8.1	22.5	329
C	3.3	7.9	7.9	23	329
D	Comp	7.8	8.1	22.5	330
E	4.9	8.7	7.9	23	329
F	4.9	8.3	8	23	329
G	Comp	8.4	8.1	23	331
H	3.3	8.9	8.4	23.5	321
I	Comp	8.2	8.2	23.5	321
J	4.9	8.4	8.3	24	321

Table 5: pH, temperature, DO and specific conductance per sample for October sampling event

Site	Sample Depth (m)	DO (mg/L)	pH	Temp (°C)	SC (µs/cm)
A	1	9.4	7.9	12.5	351
B	1.5	9.7	8.3	14	353
C	1	9.6	8.3	14.5	355
D	Comp	9.7	8.3	14.5	353
E	1.5	9.8	8.3	14.5	354
F	1.5	9.8	8.3	14.5	355
G	Comp	10.6	8.3	15	355
H	1.5	10.4	8.5	15.5	363
I	Comp	10.3	8.5	15	364
J	1.5	10.6	8.5	15.5	364

Shaded entries are composite samples in deep water locations, all others are grab samples in shallow cove-type locations.

REASONABLE POTENTIAL ANALYSIS

To address the inherent uncertainty present in a limited number of data points, USEPA has developed a statistical approach to estimate if there is "reasonable potential" to exceed water quality criteria. The statistical analysis is used to project a maximum pollutant concentration by calculating a coefficient of variation (CV, defined as the standard deviation/mean) based on available sampling data, then determining a factor based on the number of samples and the CV. The maximum observed concentration is then multiplied by this factor to determine a projected maximum pollutant concentration (USEPA, 1991). Based on this analysis, there is no reasonable potential for exceedances of CTR acute or chronic criteria from the copper concentrations observed during this sampling event. See Table 6 for a summary of the analysis.

Table 6: Reasonable Potential Analysis Summary

Reasonable Potential Analysis at 99% confidence level	
Number of samples (n)	20
Maximum concentration of n (dissolved Cu)	2.6 µg/L
Standard Deviation	0.48
Mean	1.71
Coefficient of Variation (std dev/mean)	0.28
Reasonable Potential Multiplier*	1.6
Projected Max RWC (max conc x RP multiplier)	4.2 µg/L
Most restrictive CTR criteria (chronic)	6.6 µg/L
Reasonable Potential for CTR exceedance?	No

*USEPA, 1991. Table 3-1, p. 54

RWC = Receiving Water Concentration

MONITORING PLAN/FUTURE ACTIONS

In July 2001, the State Water Resources Control Board (SWRCB) adopted an NPDES permit for Discharge of Aquatic Pesticides (General Permit No. CAG990003). The General Permit was

developed on an emergency basis to provide coverage for broad categories of aquatic pesticide use as a result of the Ninth Circuit Court's Talent decision (Headwaters, Inc. v. Talent Irrigation District, 2001), which found that discharges of pollutants from the use of aquatic pesticides require coverage under an NPDES permit.

The permit grants a categorical exception from the water quality criteria and objectives for priority pollutants for the application of aquatic pesticides. This exception is short-term (including seasonal) and applies only to the use of aquatic pesticides, such as copper sulfate. Any impacts on beneficial uses must be temporary in nature, and must allow for full restoration of pre-project water quality conditions and protection of beneficial uses. Effluent limitations are narrative and include requirements to implement appropriate best management practices and comply with all pesticide label requirements. Coverage is available to "public entities" for resource or pest management, based on the provisions of the SWRCB's State Implementation Policy of the CTR.

The General Permit's Monitoring and Reporting Program (MRP) requires that dischargers submit a monthly report to the appropriate RWQCB documenting specific information regarding each aquatic pesticide use site. The discharger must also submit an annual report that summarizes the objectives of the MRP, results, and interpretation of data. Any further copper sulfate applications at North Haiwee reservoir may be regulated under this statewide General NPDES Permit for Aquatic Pesticide applications, with a site-specific MRP to ensure protection of beneficial uses.

CONCLUSIONS AND RECOMMENDATIONS

Dissolved copper concentrations were well below CTR chronic criteria, and the measured concentrations indicate that the average percentage of dissolved copper to total copper is 44 to 52 percent. Hardness measurements showed little variability from site to site, but seasonable variability was apparent, with an average of 71 mg/L CaCO₃ in July, increasing to an average of 83 mg/L in October. The reservoir was not stratified during the either sampling event, as evidenced by relatively consistent temperature, pH and DO readings in the water column with depth.

Statistical analysis indicates that, based on the data collected during both sampling events, there is no reasonable potential to exceed CTR chronic criteria. Based on the information summarized in this report, Regional Board staff recommend removing North Haiwee Reservoir from the CWA Section 303(d) list of impaired waterbodies during the next 303(d) listing cycle. The next opportunity to amend the Regional Board's 303(d) list is scheduled for June 2004.

In lieu of immediate action on the 303(d) list, Board staff recommend that the Regional Board adopt Resolution No. 6T-2003-(Proposed), which acknowledges that North Haiwee Reservoir is currently attaining water quality standards for dissolved copper, a program is in place to assure future attainment of standards, and a formal decision has been made to remove the North Reservoir from the 303(d) list.

REFERENCES

Horne, A.J. and Goldman C.R., 1994. *Limnology*. Second Edition. McGraw-Hill, Inc.

Lahontan RWQCB, 2001. *Progress Report: Total Maximum Daily Load for Copper, Haiwee Reservoir*.

USEPA, 1991. *Technical Support Document for Water Quality-based Toxics Control*. EPA/505/2-90-001, Office of Water.

-----1996. *The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion*. EPA 823-B-96-007, Office of Water.

APPENDIX A

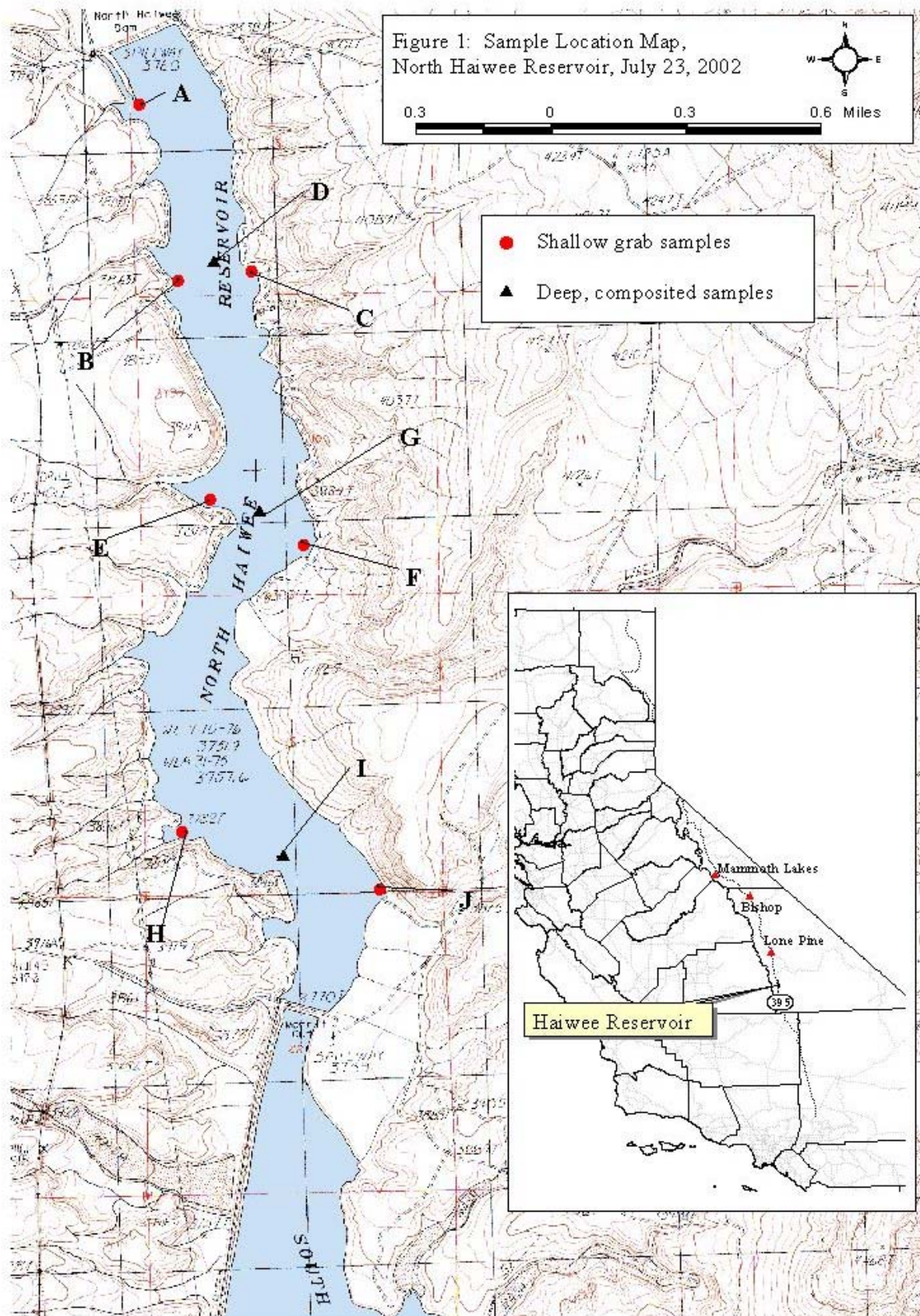
Figure 1: Sample Location Map and Reservoir Location Inset Map

Figure 2: Dissolved and Total Copper Concentrations with CTR Criteria by Sampling Site for July

Figure 3: Water Temperature v. Depth by Sampling Site for July

Figure 4: Dissolved and Total Copper Concentrations with CTR Criteria by Sampling Site for October

Figure 5: Water Temperature v. Depth by Sampling Site for October



**Figure 2: Dissolved & Total Copper Concentrations
and CTR Dissolved Copper Criteria
North Haiwee Reservoir, July 23, 2002**

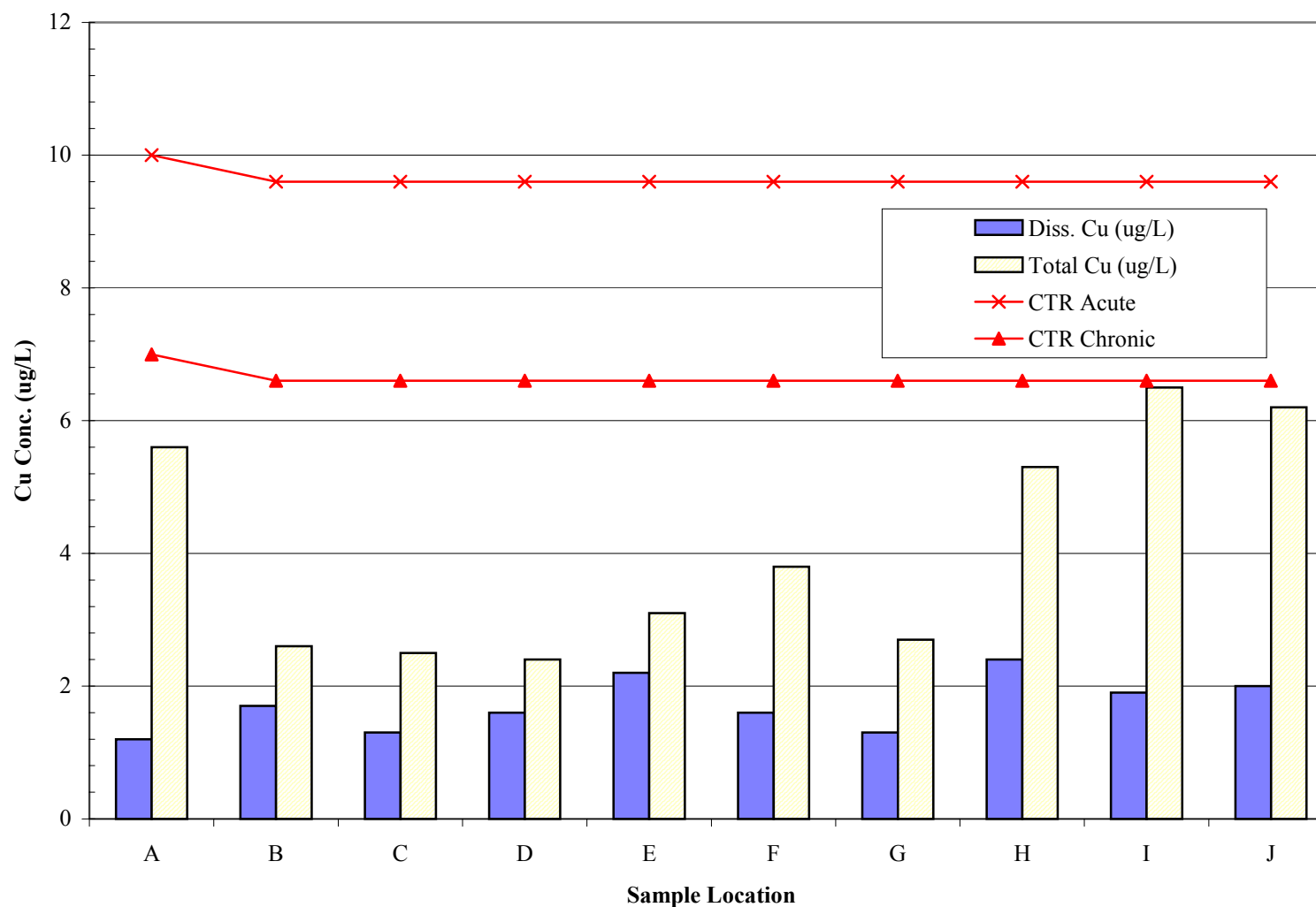
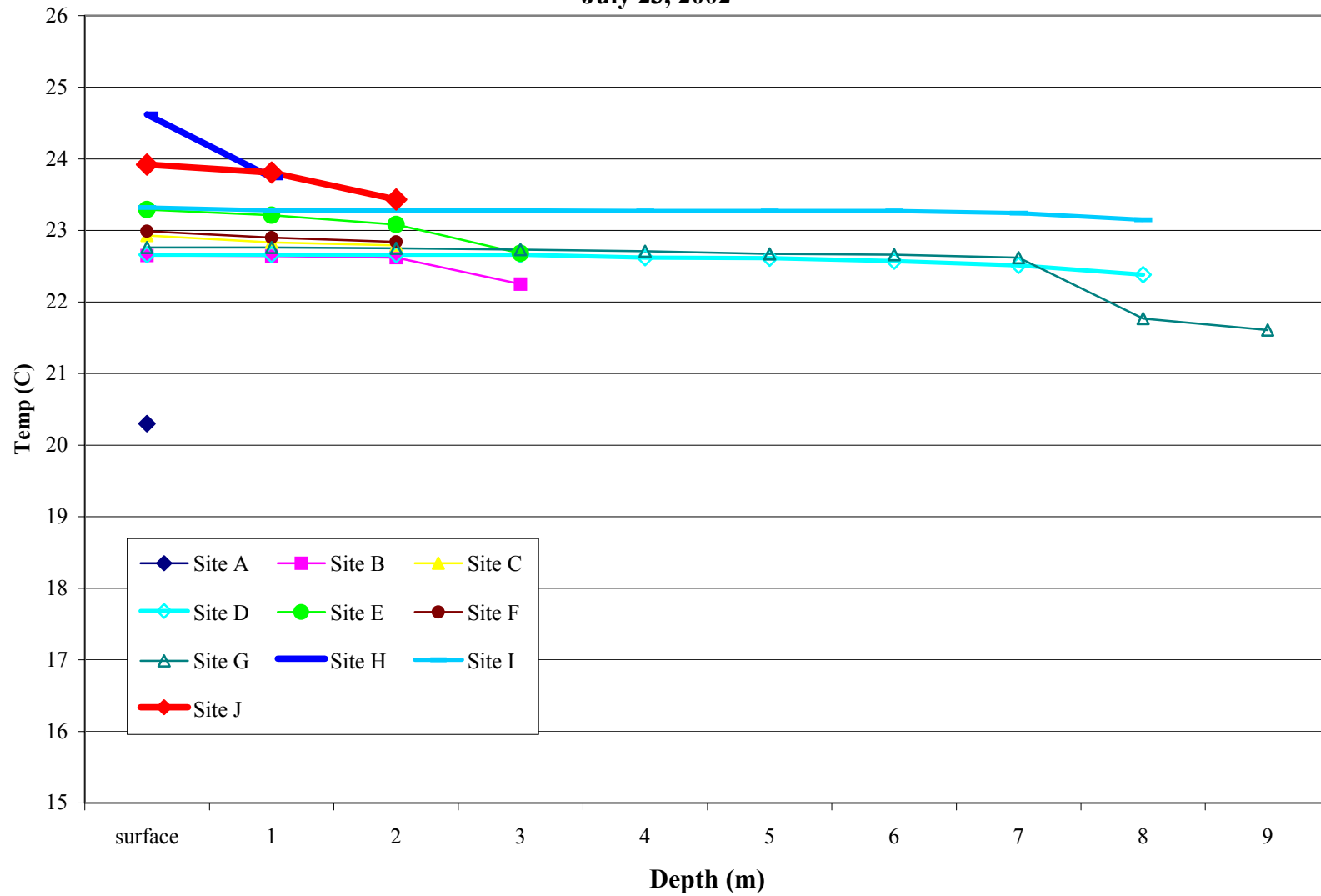
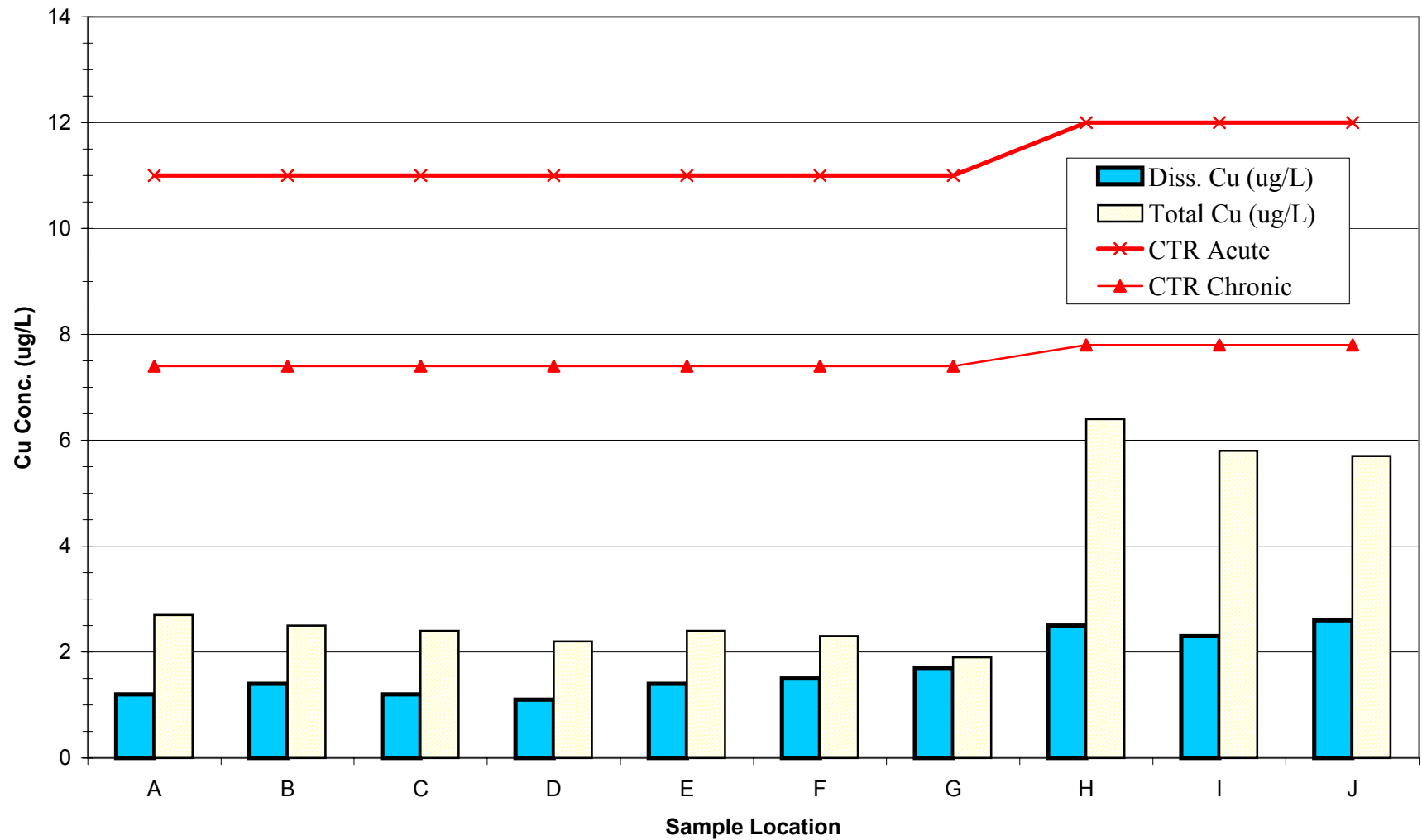


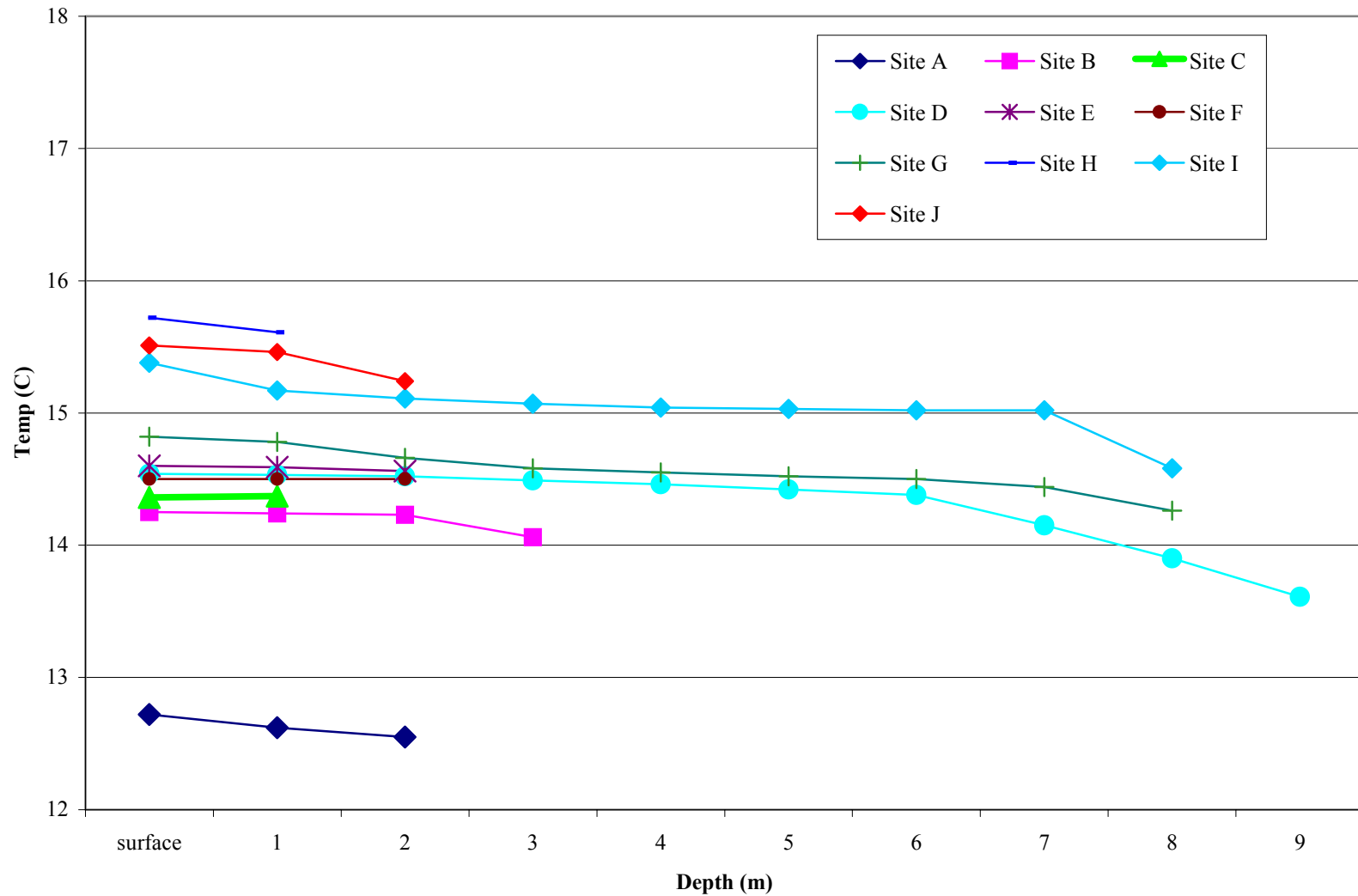
Figure 3: Water Temperature v. Depth by Sampling Site
North Haiwee Reservoir
July 23, 2002



**Figure 4: Dissolved & Total Copper Concentrations
and CTR Dissolved Copper Criteria
North Haiwee Reservoir, October 22, 2002**



**Figure 5: Water Temperature v. Depth by Sampling Site
North Haiwee Reservoir
October 22, 2002**



ATTACHMENT 1

Resolution R6T-2003- (PROPOSED)

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

RESOLUTION R6T-2003-(PROPOSED)

**TO REMOVE NORTH HAIWEE RESERVOIR FROM THE
CLEAN WATER ACT SECTION 303(d) LIST OF IMPAIRED WATERBODIES**

WHEREAS, the California Regional Water Quality Control Board, Lahontan Region, finds:

1. Section 303(d) of the federal Clean Water Act requires states to identify surface water bodies that do not meet water quality standards, to prepare strategies called Total Maximum Daily Loads (TMDLs) incorporating load and/or wasteload allocations to ensure attainment of standards in these waters. A waterbody may be removed from the 303(d) list if it can be demonstrated that water quality standards are being met, or controls are in place to ensure attainment of standards by the next listing period, and
2. The Haiwee Reservoir complex is located in Inyo County, south of the town of Lone Pine. It consists of two interconnected reservoirs; North and South Haiwee. It functions as a water supply reservoir in the Los Angeles Department of Water and Power's Los Angeles Aqueduct-Owens River system, and
3. The Haiwee Reservoir complex was placed on the Section 303(d) list of waterbodies requiring TMDLs because of impacts due to copper. Copper sulfate is used at the reservoir to control algae, which can impart foul taste and odors to the drinking water stored in the reservoir, and
4. In June 2001, Regional Board staff submitted a technical TMDL Progress Report to the USEPA regarding Haiwee Reservoir's copper impairment. The Progress Report outlined several key data gaps, including a lack of information on dissolved copper concentrations in the reservoir, and
5. In July and October 2002, Regional Board staff, together with staff of the United States Geological Survey, collected water quality samples at North Haiwee Reservoir to determine the current nature of dissolved copper impairment and the reservoir's limnological characteristics, and
6. Regional Board staff have summarized the results of the sampling program in a draft staff report. The data indicate that North Haiwee Reservoir is in compliance with water quality standards for dissolved copper. The draft staff report also includes a "reasonable potential" analysis that shows that current copper concentrations do not present a risk of exceeding water quality standards for copper at a 99 percent confidence level, and

7. A Notice of Availability for the draft staff report was to mailed to all parties on the Haiwee Reservoir TMDL mailing list. Copies of the draft staff report were sent to key stakeholders and agencies, and were also made available on the Internet, and
8. The Regional Board heard and considered all written public comments and all testimony presented at a duly noticed public hearing held at its regular June 11 and 12, 2003 meeting.
9. To ensure protection of beneficial uses and continued attainment of water quality standards, future copper sulfate applications at the North reservoir may be regulated under the State Water Resources Control Board's NPDES permit for Discharge of Aquatic Pesticides (General Permit No. CAG990003), which includes requirements for monitoring and reporting, and
10. Based on the information presented, Regional Board staff recommend that North Haiwee Reservoir be removed from the Clean Water Act Section 303(d) list of impaired waters during the next assessment cycle, scheduled for June 2004. South Haiwee Reservoir will remain on the 303(d) list until data is submitted that indicate it is in compliance with water quality standards for copper.

THEREFORE BE IT RESOLVED:

1. North Haiwee Reservoir is attaining water quality standards for copper, as stated in Finding 6, and controls are in place to ensure continued attainment of water quality standards and beneficial use protection, as stated in Finding 9.
2. The Regional Board hereby adopts Resolution 6T-2003-(Proposed), to remove North Haiwee Reservoir from the Clean Water Act Section 303(d) list of impaired waters during the next listing cycle, scheduled for June 2004.

I, Harold J. Singer, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of a Resolution adopted by the California Regional Water Quality Control Board, Lahontan Region, on June 11, 2003.

HAROLD J. SINGER
EXECUTIVE OFFICER